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TECHNICAL REPORT No. 405-45

GERMAN MINE CLOCKS, PERIOD DELAY MECHANISMS, STERILIZERS AND ASSOCIATED DEVICES

September 1945

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TECHNICAL REPORT No. 405-45

GERMAN MINE CLOCKS, PERIOD DELAY MECHANISMS, STERILIZERS AND ASSOCIATED DEVICES

SUMMARY

This report contains information on the German mine arming clocks, period delay mechanisms, sterilizers, scuttling clocks and associated devices.

September 1945

U. S. NAVAL TECHNICAL MISSION IN EUROPE

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GERMAN MINE CLOCKS, PERIOD DELAY MECHANISMS, STERILIZERS AND ASSOCIATED DEVICES

1. Introduction.

The information contained in this report was obtained through examination of captured German documents and interrogation of German prisoners and scientists having knowledge of the subject matter. Specimens are being prepared for shipment to the U. S. Naval Ordnance Investigation Laboratory. It is contemplated that the information contained in this report will amplify that gained from examination of and experimentation with such specimens. German pamphlets on UES II (6 day clock); UES IIa (modified 6 day clock); Lichtsicherung (LiS) (anti-recovery switch for 6 day clock); Pausenuhr (on-off arming-disarming clock) and blueprints of the M3 mine unit with UES IIa and ZE III (200 day clock) have been forwarded to OP-16-PT by NavTecMisEu letter serial 930 of 10 September 1945.

2. General.

The clocks and associated devices described herein operate on one of the following principles; electrical, mechanical, electrolytic or electro-mechanical combination. These devices are used separately or in combination in ground-influence, moored-influence, moored contact or drifting contact mines. The following mechanisms are described:

Arming clocks, disarming clocks, sterilizers, on-off arming-disarming clocks, scuttling clocks and period delay mechanisms.

3. Arming Clocks.

(a) UES I.

The UES I (Fig. 1) (original model with soluble washer-revised model without soluble washer) was the first hydrostatic arming clock used in German sea mines. To operate properly this clock requires constant hydrostatic pressure in depths of 5 meters or more; after a continuous run of 20 to 30 minutes the mine is armed. This clock was replaced by the UES II.

3. Arming Clocks (Cont'd.)

(b). UES II.

The UES II (Figs. 2 and 3) is a hydrostatically operated clock requiring an initial pressure equal to 5 meters for starting, however, it will continue to run even if pressure is removed. This clock can be set to arm the mine at any time from ½ hour to 6 hours in 15 minute intervals, or from ½ day to 6 days at 6 hour intervals. The purpose of this clock is to delay the switching-in of the detonator into the mine circuit to prevent premature firing until the mine unit has properly oriented itself.

(c) UES IIa.

The UES IIa (Figs. 2 and 3) is the same in all respects as the UES II except it requires constant pressure for continuous running.

(d) Clock Starter Plate.

The clock starter plate for the UES II and UES IIa can accommodate the LiS (anti-recovery switch) and/or the Vorkontakt (intermediate contact).

(e) UES II and UES IIa with LiS.

The LiS is an anti-recovery switch used with the UES II and UES IIa (Figs. 3, 4, 5 and 6). The pre-set time of the UES must run off for the LiS to operate. After normal operation of the clock if the mine is removed to a depth of less than 5 meters the mine will explode, OPERATION - Before pressure has been applied to the clock (Fig. 3), contact arm 10 housing contact 11, is held off contact 14 by retaining screw 6. When the mine reaches a depth of 5 meters hydrostatic pressure forces 6 which is attached to hydrostatic piston 4 upward allowing spring loaded lever 10 to assume the position illustrated in Fig. 4. Under normal operating conditions contacts 11 and 14 remain open. A reduction of water pressure of between 0.2 and 2 meters causes 6 to force spring lever 10 downward closing contacts 11 and 14 and firing the mine.

(f) UES II and UES IIa with Vorkontakt.

The Vorkontakt (Figs. 7 and 8) is an intermediate switch which

3. Arming Clocks (f)(Cont'd.)

is closed 15 to 20 minutes after the UES has started. Its purpose is to switch in the anti-recovery switch (LiS) and any other scuttling charges incorporated in the mine. OPERATION - The Vorkontakt in either the UES II or UES IIa is a double pole switch consisting of two sets of leaf springs held apart by a grooved roller, 43, Fig. 7. One set of leaf springs, 45, fits into the groove on the roller which is geared to the clockwork mechanism. Rotation of the roller in a clockwise direction causes leaf springs 44 and 45 to make contact and switch in the LiS.

4. Sterilizers (Zeit Einrichtung).

All Zeit Einrichtungen with the exception of the ZE IVb are used exclusively as sterilizers. Although the ZE IVb is a sterilizer it was used as an anchor release clock for the SMC mine anchor and in this case was designated NU II.

(a) ZE.

The ZE and ZE I were developed simultaneously but the ZE was abandoned in favor of the ZE I. Details on the ZE were unavailable and no specimens were found.

(b) ZE I.

The ZE I (Figs. 9, 10, 11 and 12) is a spring driven 80 day mechanical sterilizing clock used in the EMC, EMD, EMF, SMA, TMA and TMB mines. OPERATION - Closure of UES contacts allows current to flow through solder plug T of the ZE I (Fig. 9). When T melts it releases clock starting lever L, (Fig. 9a). 40 to 50 minutes after the ZE I starts switches C, D, E and F are closed, Fig. 11. C and D put the clock safety feature into the circuit; E and F switch the detonator into the circuit and make the mine ready for normal firing. At the end of the pre-set period contacts C, E and F open and A and B close, Fig. 12. A and B put the battery across the flooder detonator and the resulting explosion scuttles the mine.

(c) ZE II.

The ZE II (Figs. 13, 14, and 15) is a spring driven mechanical sterilizing clock that can be set from 1 to 6 days at 6 hour intervals.

4. Sterilizers (c)(Cont'd.)

On the ZE II the UES is connected across terminals 1 and 3, the battery is connected across 1 and 2 and the mine unit is connected across 4 and 5 (Fig. 15). When the UES has concluded its run a potential is applied across 1 and 3 blowing fuse F and freeing the escapement to start the ZE II. At the completion of the ZE II run, leaf springs A and B slide into groove C (Fig. 14), contacts 1 and 2 close shorting out the battery and contacts 4 and 5 open, opening the firing circuit. Samples of the ZE II have been shipped to the U. S. Naval Ordnance Investigation Laboratory.

(d) ZE III.

The ZE III (Figs. 16, 17, 18, 19 and 20) has the same function as the ZE I but is designed primarily for the LMB mine which cannot accommodate the ZE I. It is a 200 day clock driven by two small springs wound by a small 9 volt motor. The clock consists of three main parts: the winding system, the clockwork and switches and the safety mechanism. This clock can be set from 5 to 200 days by turning the setting dial clockwise past zero to the desired position. Termination of the UES run connects a 9-12 volt battery across terminals 7 and 8 starting the clock motor. After a run of 10 to 15 seconds contacts 1-2, 3-4 close and the motor continues to run for 40 to 50 seconds until both springs are wound. The safety spring winder which is driven by a notched disc automatically cuts off the motor current for 30 minutes when initial winding is completed. After a delay of 30 minutes the motor starts again rewinding the springs. This process continues until the ZE III reaches its pre-set period at which time contacts 1-2, 3-4, and 7-8 are opened and contacts 1-3 and 5-6 close. (Diagram 20).

If a mechanical failure occurs after the clock starts the independent safety system operates. 60 to 70 minutes after the failure all contacts are made in the same manner as though the clock had completed its run.

(e) ZE III for 360 Days.

This clock (Fig. 20a) is similar to the ZE III except it was designed for 360 days. It was under development at the close of the war and the only specimen available is a laboratory model.

4. Sterilizers (Cont'd.)

(f) ZE IV.

The ZE IV (Figs. 21 and 22) is a 45 day mechanical, spring-driven sterilizing clock designed for use in the OMA mine. The clock is set by rotating the dial counterclockwise to the desired period opposite the red arrow. At the end of the clock's run lug A, Fig. 22, trips spring-retained rocker arm B, which rotates lever cam C releasing spring loaded striker D. This clock was not used operationally because the time period was considered too short.

(g) ZE IVa.

The ZE IVa (Figs. 23, 24, 25 and 26) is a 60 day sterilizer developed to replace the ZE IV and it operates on the same principle. When the ZE IVa is used in the OMA mine the detonator is connected across terminals 45, Fig. 25. The clock is started by cam 39, Fig. 25. At the end of its run striker D, Fig. 26 is released in the same manner as in the ZE IV disengaging the knife switch A (Fig. 26) and opening the detonator circuit, thereby disarming the mine.

(h) ZE V.

The ZE V was an electrolytic sterilizer abandoned and superseded by the ZE VI.

(i) ZE VI.

The ZE VI (Figs. 27 and 28) is an electrolytic 200 day cadmium cell sterilizer. The cell consists of a silver plated fine copper wire. The silver plating is covered with a thin layer of gold except for one minute spot. Enough copper to initiate galvanic action but to delay action on the silver plate is deposited on this spot. When the ZE is switched on electrolytic action takes place. The small particle of copper on the fold plate is attacked first, next the silver plating is expended and finally when the copper wire is consumed on the 200th day a spring loaded switch is released shorting out the battery and sterilizing the mine.

5. Period Delay Mechanisms (Zahl Kontakt).

All German period delay mechanisms are spring driven clockwork

5. Period Delay Mechanisms (Cont'd.)

systems whose escapements are released by electromagnets. However, the mine firing unit must first be activated before the escapement electromagnet of the period delay mechanism can be energized. The Bureau of Ordnance is informed concerning the operation of period delay mechanisms described below except the ZK III and minor changes in some of the ZK II's.

(a) ZK I.

The ZK I is a mechanical 6 place period delay mechanism whose electromagnet operates at 8 to 12 volts and 0.2 amps. The time for the completion of one step-up cycle after actuation is approximately 40 seconds. The ZK I was developed for the M 1 mine unit and was replaced by the improved ZK II.

(b) ZK II.

The ZK II (Fig. 29) is a mechanical 12 place period delay mechanism whose electromagnet operates at 8 to 12 volts and 0.2 amps. The time interval for the completion of one step-up cycle after actuation is two minutes. The ZK II was used with the M 1, A 1, A 4 and Ma 2/3 mine units. In the MA 2/3 it was designed to operate after the Magnetic actuation.

(c) ZK IIa.

The ZK IIa is the same as the ZK II except the time interval is increased from two minutes to four minutes.

(d) ZK IIb.

The ZK IIb is the same as the ZK II except the electromagnet operates off the microphone battery at 3 to 4 volts and 0.5 amps. This clockwork was used with the AT 1 and AT 2 mine units.

(e) ZK IIc.

The ZK IIc is the same as the ZK II but is designed to operate on a very short electrical impulse. This modification enables the ZK IIc to be used with the MA 2/3 mine units and to operate after the Magnetic and Acoustic systems have been activated.

5. Period Delay Mechanisms (Cont'd.)

(f) ZK IId.

This device was under development at the close of the war, and no information is available.

(g) ZK IIe.

The ZK IIe (Fig. 30) is a specially modified period delay mechanism used with the MA 1 St. mine unit. It is operated by the Magnetic system of the MA 1 St. A magnetic actuation starts the ZK and after 15 seconds cam A opens the normally closed switch A for approximately 2 minutes. If a proper acoustic actuation does not occur in the 15 second interval the mine will not fire because switch A re-opens, de-energizing the acoustic component. After 84 such actuations cam B closes switch B permanently putting the acoustic system in the circuit.

(h) ZK IIf.

The ZK IIf is the same as the ZK II except the time interval is decreased from 2 minutes to 5 seconds.

6. Miscellaneous Clockwork Mechanisms.

(a) Pausenuhr (Arming and Disarming Clock).

The Pausenuhr (Figs. 32, 33, 34 and 35) is an 18 day electrically driven ON-OFF clock developed to arm and disarm a mine once every 24 hours. Settings are made in multiples of 3 hours for a 24 hour cycle; example: 3 hours ON 21 hours OFF, 6 hours ON 18 hours OFF, etc.

The Pausenuhr was designed for use with the UES in the EM, LM, RM, SM, TM, and MT mine series.
OPERATION - When the UES has concluded its run a potential is applied across terminals 1 and 2 (Fig. 36) allowing current to flow through solder plug 14 (Fig. 32) which melts releasing starting lever 15. After the clock has run for 2 hours star switch 7 is moved by a pin on the bottom of the setting dial bearing 19. The step-up of the star switch arms the mine for the pre-set period. At the end of the pre-set period switch screw 18 turns star switch 7 (Fig. 34) opening switch A and disarming the mine for the remainder of the 24 hours. This process is repeated for 18 days at which time the grooved switch roller 10,

6. Miscellaneous Clockwork Mechanisms (Cont'd.)

(Fig. 33) driven by clockwork 5 and 6 accepts spring 11 to close switch B thereby permanently arming the mine. SETTING - The switching screw 18 is removed and the setting dial is turned 360 degrees counterclockwise to the zero position. One of seven possible delays is selected and screw 18 is replaced.

(b) Entscharfer Werke (EW)(Disarming Clock).

The EW is a 12 hour test clock used in the EMF, LMF AND SMA mines. Specimens of this clock were recovered by the U. S. Navy in 1943 and consequently details of construction and operation are already known.

(c) Verzögerungs Kontakt (VK)(Delay Contact).

The VK (Figs. 37 and 37a) is a spring driven clockwork that runs for 38 seconds. It is used with the M 1 mine unit and is designed to prevent the mine from firing unless the magnetic influence persists at the end of its pre-set time.
OPERATION - The setting dial is set to the desired number of seconds. When the M 1 mine unit is activated it causes the clock solenoid to operate thus starting the clock. One second before the end of the pre-set time cam C, (Fig. 37) opens switch A which opens the hold-on circuit for about one second. When the hold-on circuit is opened the needle will come off the firing contacts, however, if magnetic influence is present at the end of the pre-set time C will close the firing circuit and fire the mine. If the mine does not fire after approximately 80 actuations of the VK, switch D closes cam E thus arming the mine permanently allowing it to fire normally.

(d) Verzögerung Werke (VW)(Delay Clock).

The VW (Figs. 38 and 39) is a spring wound 6 day scuttling clock used in the EMS mine. It can be set from 6 hours to 6 days by intervals of 6 hours.
OPERATION - A soluble washer in switch C (Fig. 39) dissolves allowing a potential to be applied across terminals 1 and 3 which blows fuse F and starts the clock. After the clock runs for approximately 10 minutes arming switch A closes and the mine is armed. At the end of the pre-set time scuttling switch B closes placing the detonator across the battery to destroy the mine.

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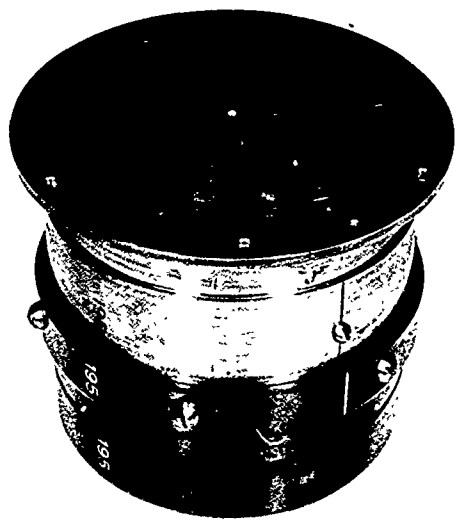


Figure 1

U.E.S. 1

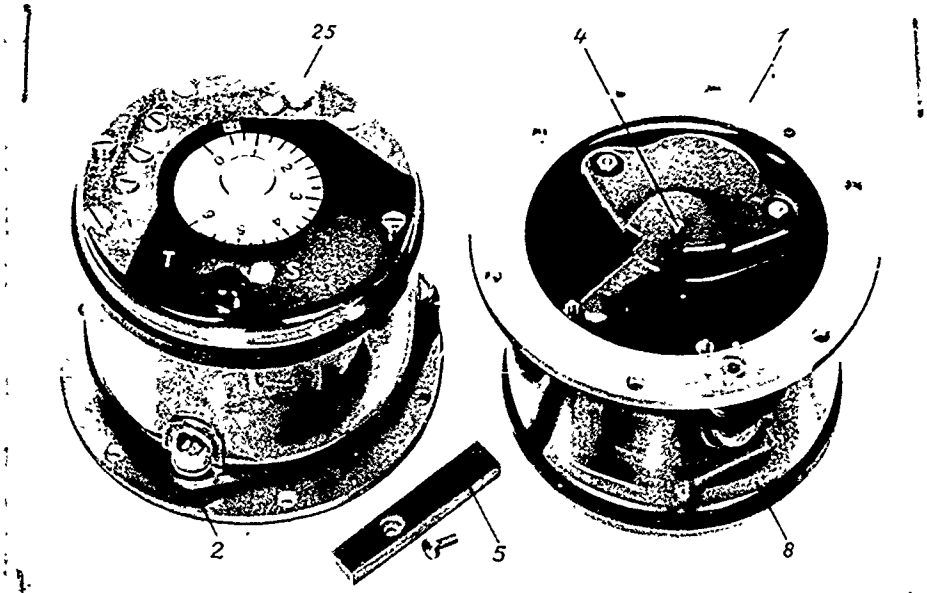


Figure 2

U.E.S. II and IIa

1) Mounting Ring	5) Safety Bar
2) Shock Absorbers	8) Plexi-glass Case
3) Starting Rod	9) Plexi-glass Cover

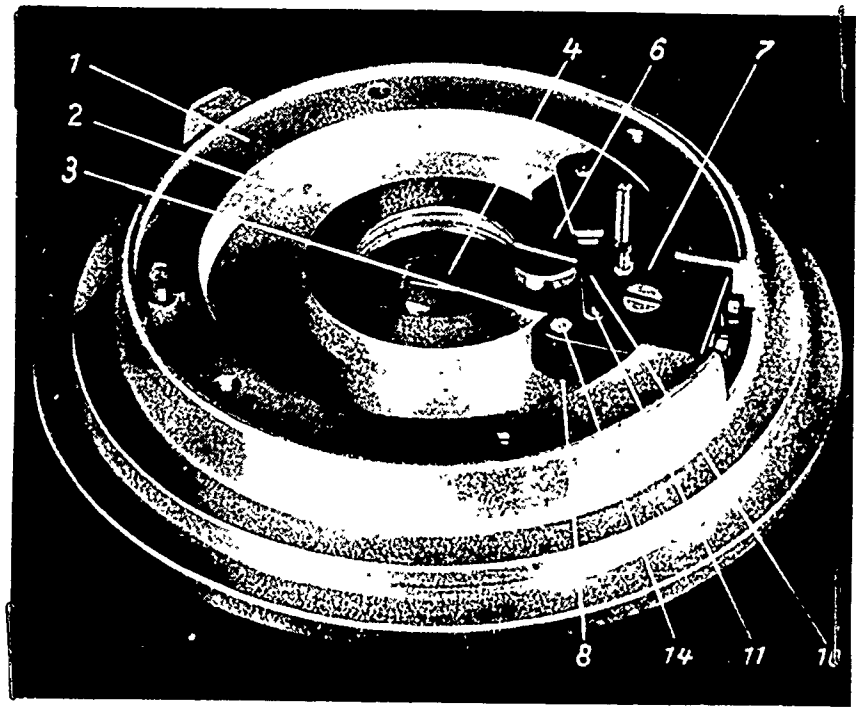


Figure 3

Clock Starter Plates Showing the LiS in the Unarmed Position

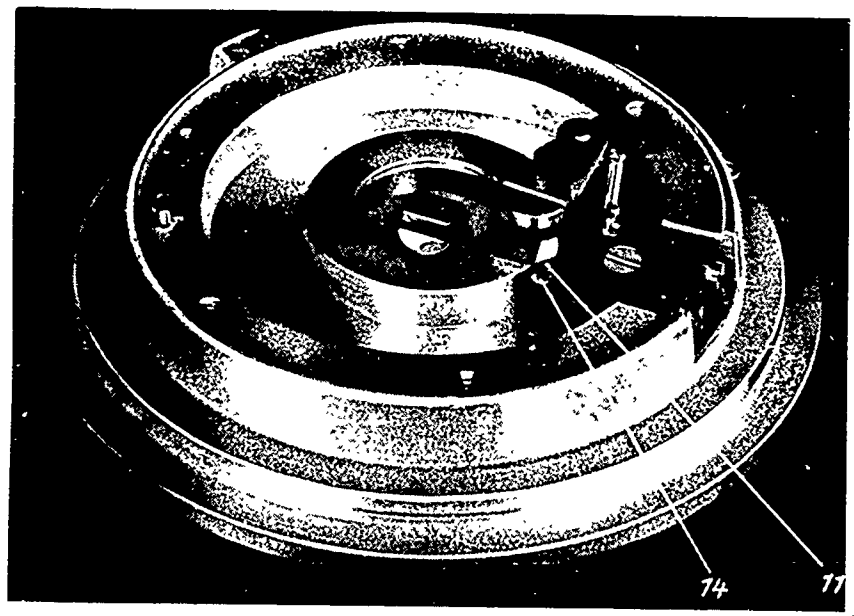


Figure 4

Clock Starter Plate Showing the LiS in the Armed Position

1) Clock Starter Plate
2) Annular Groove
3) Radial Groove
4) Hydrostatic Piston
5) Carrier Block for Switching Screw 6
6) Switching Screw
7) Contact Plate
8) Insulation Plate
9) Lever
10) Contact Spring
11) Spring Contact
12) Clamping Screw
13) Clamping Screw
14) Contact
15) Lead Wire

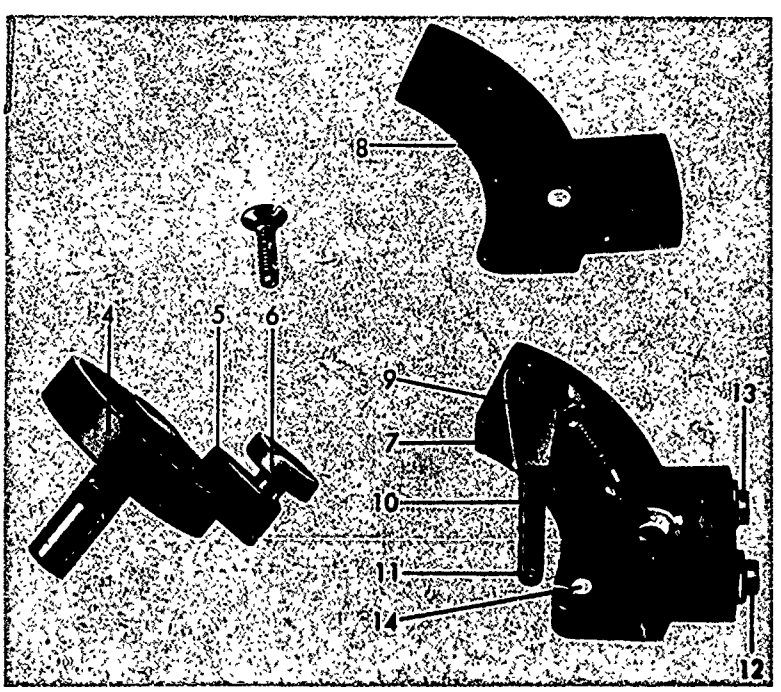


Figure 5

LiS Components

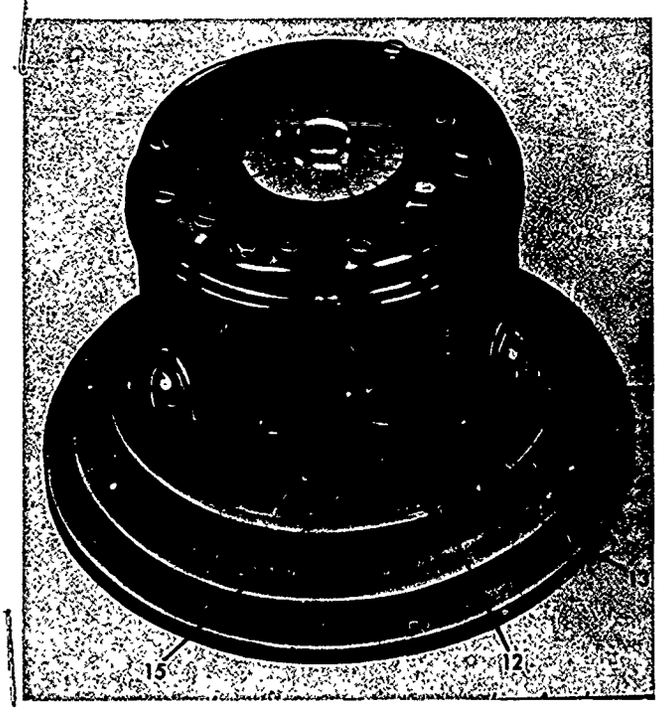


Figure 6

U.E.S. II or IIa Showing the Terminal Board for the LiS

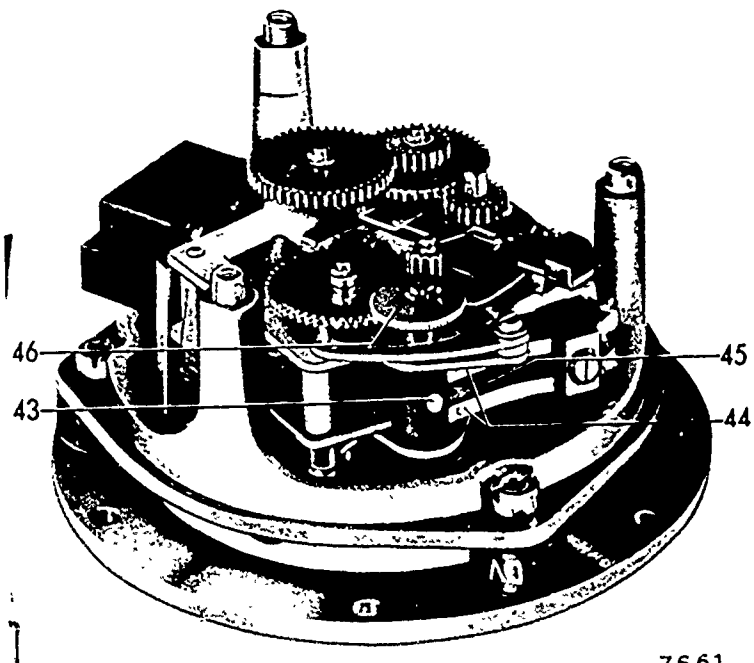


Figure 7

U.E.S. II or IIa With Intermediate Switch (Vorkontakt)

43) Switching Roller
44) Contact Springs
45) Contact Springs
46) Regulating Disc

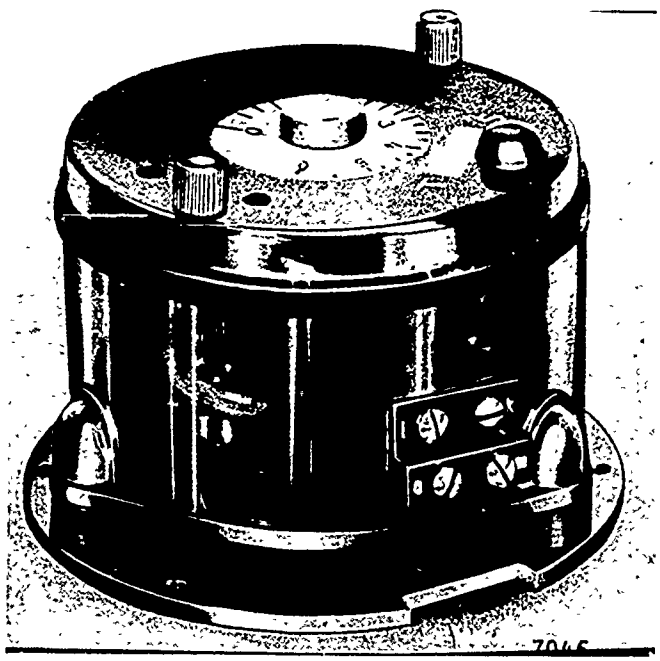


Figure 8

U.E.S. II or IIa Showing the Terminal Board for the Intermediate Switch

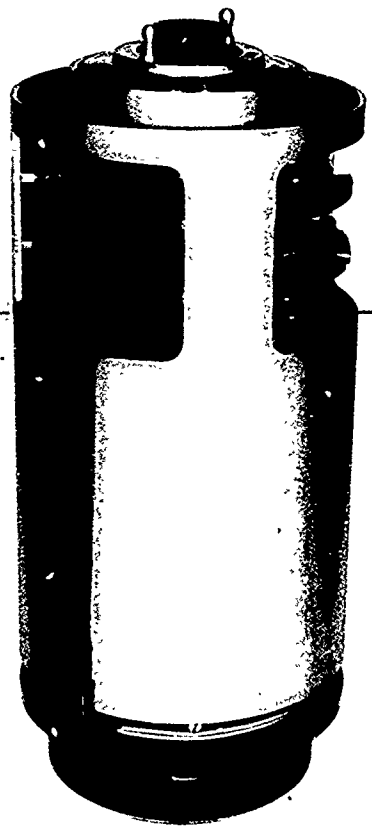


Figure 9

Z.E. 1

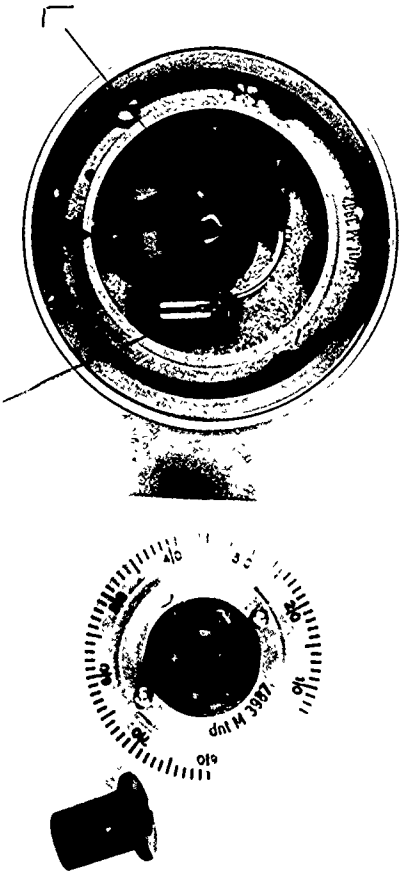


Figure 9a

Z.E. I (Top View)

POSITION OF SWITCHES DURING VARIOUS STAGES OF OPERATION OF THE Z.E.I

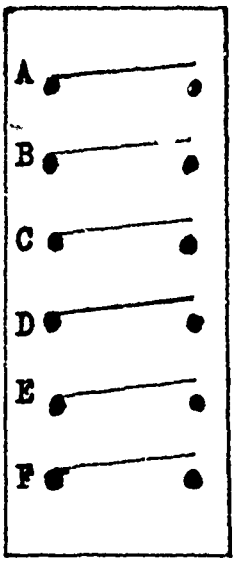


Fig.10

Position of switches before the Z.E.I has started

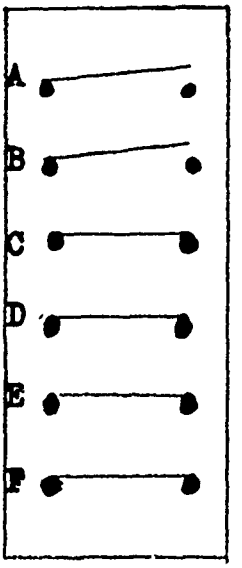


Fig. 11

Position of switches 40 to 50 min. after the Z.E.I has started

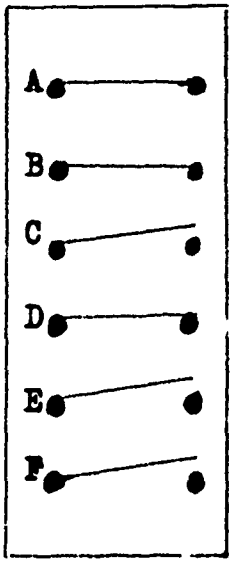


Fig.12

Position of switches after the Z.E.I has run off

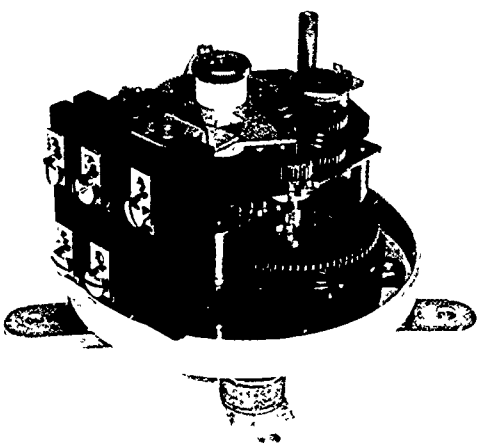
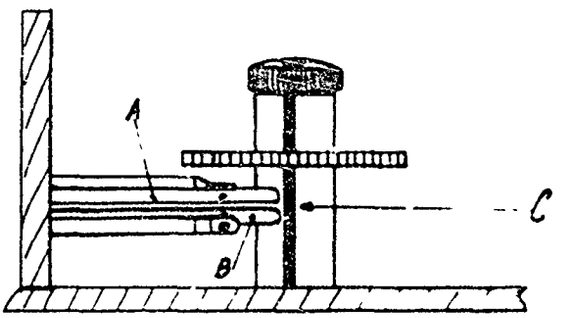


Figure 13

ZE II



SWITCH ROLLER FOR ZE II

FIG. 14

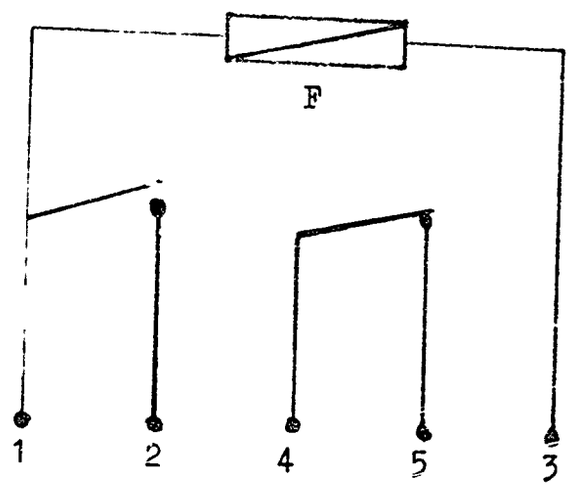


Figure 15

Wiring Diagram for the Z.E. II

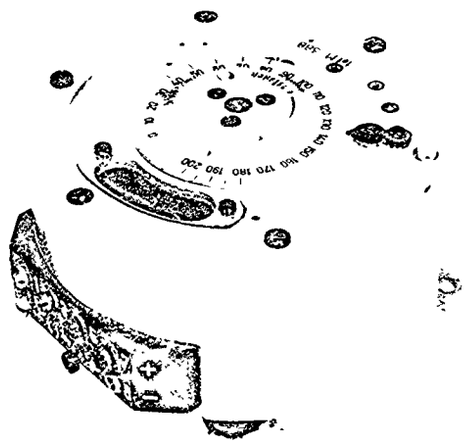


Figure 16

Z.S. III

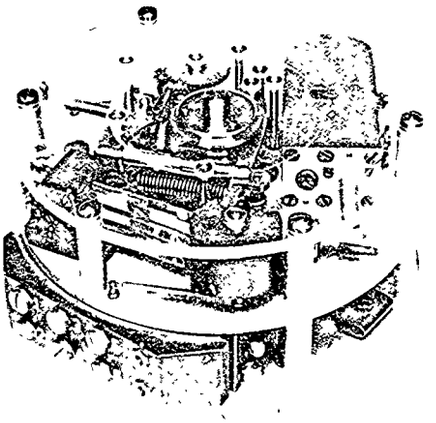


Figure 17

Z.E. III

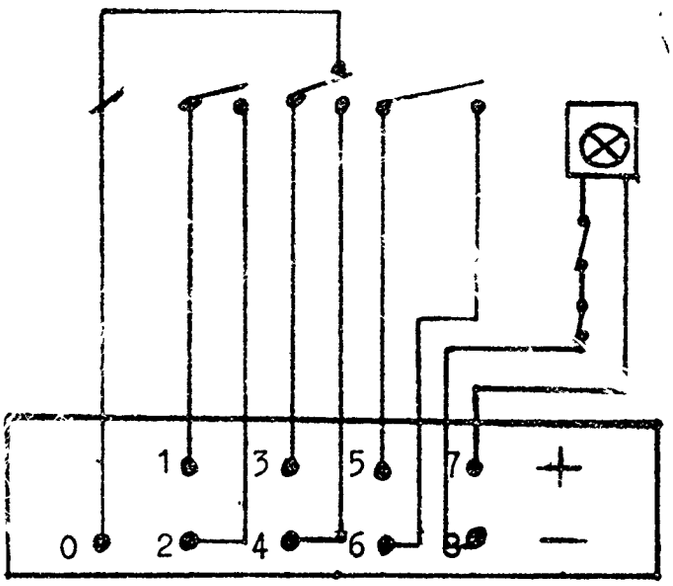


Figure 18

Wiring Diagram of the Z.E.III Showing the Position of Switches Before the U.S.S. Has Run Off

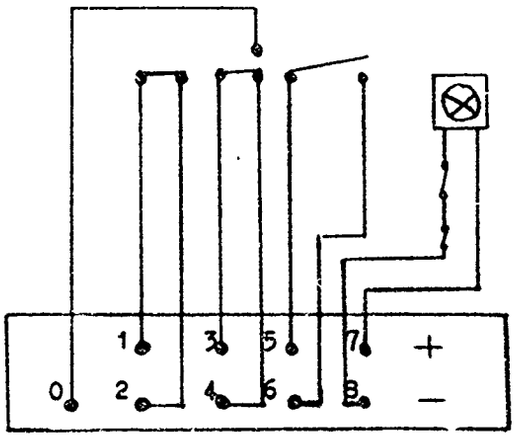


Figure 19

Wiring Diagram of the Z.E.III Showing the Position of the Switches 10-15 Seconds After the Z.E. Has Started

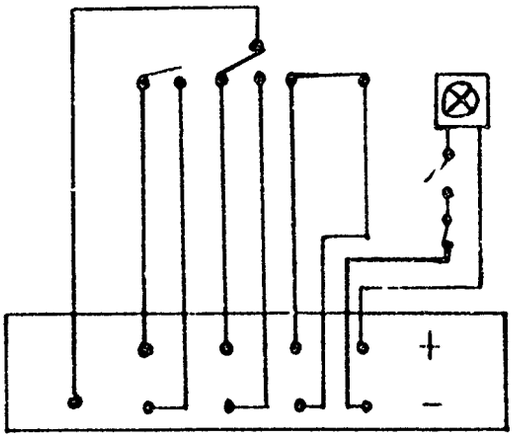


Figure 20

Wiring Diagram of the Z.E.III Showing the Position of the Switches After the Z.E. Has Run Off its Preset Time

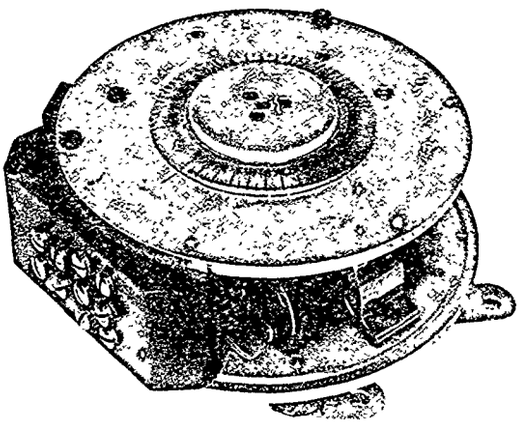


Figure 20a

Z.E. III For 360 Days

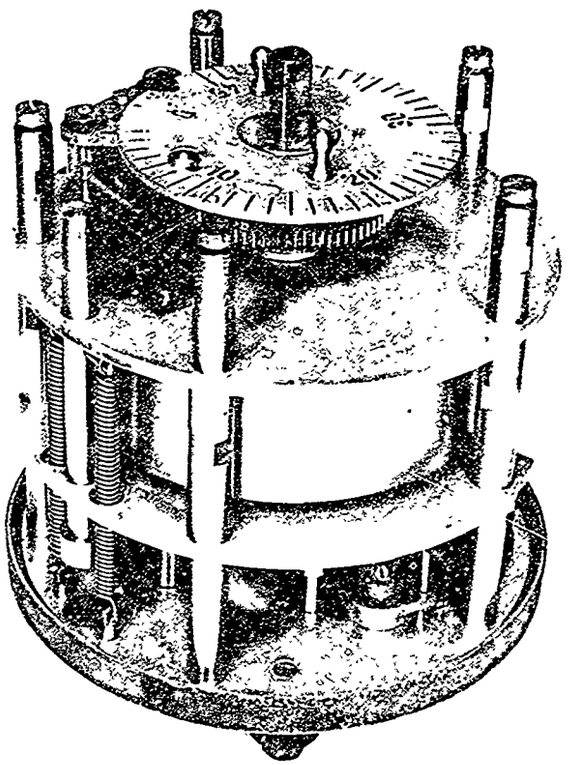


Figure 21

Z.E. IV

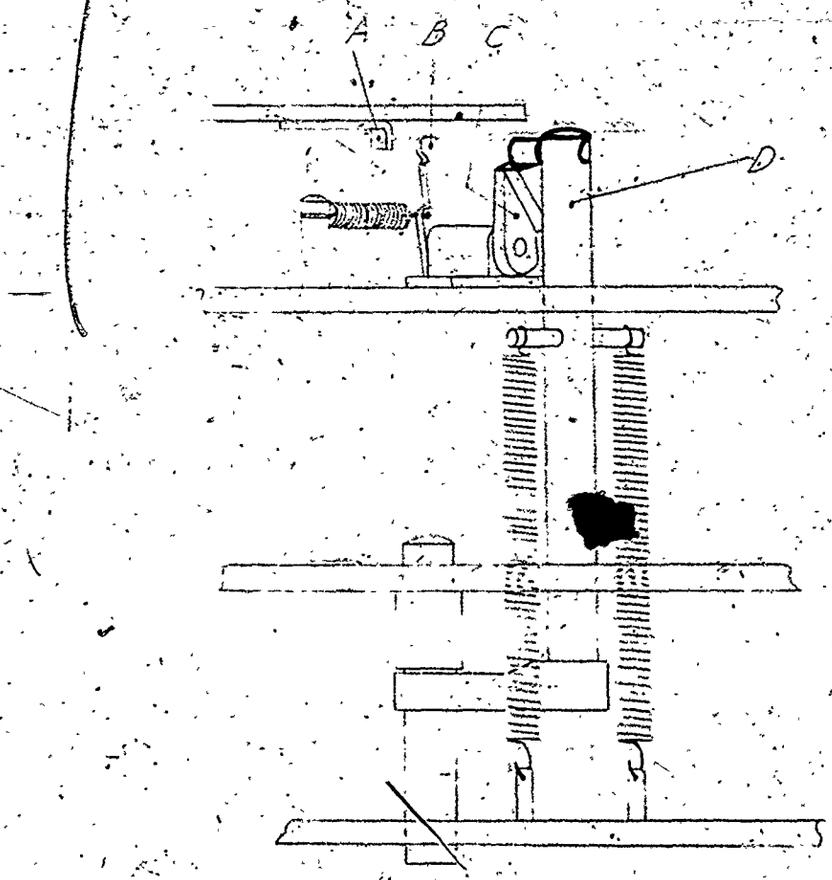


FIG. 22

ZE-II

OKH Hor Rist-AWa B DIN A 4 Master 43

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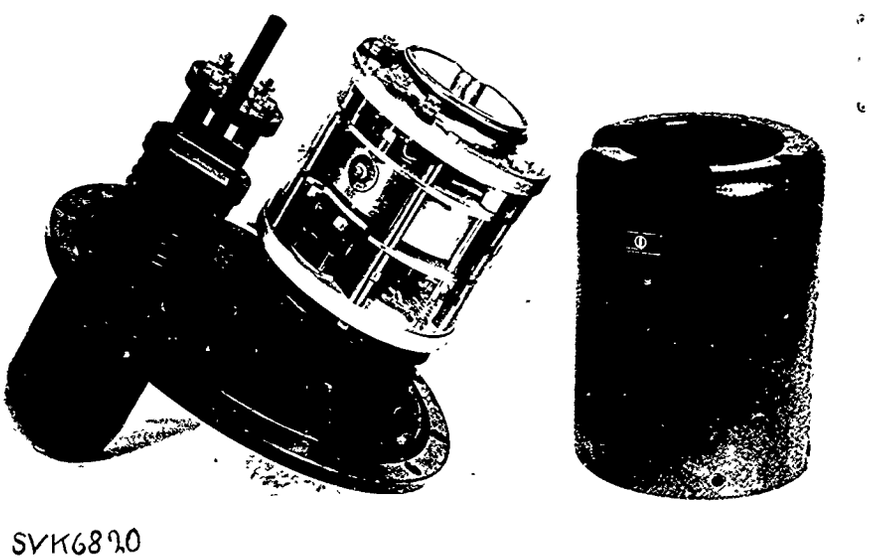
Gebr. Wiskemann, Berlin SW 2, Stallschreiberstr.



SVK6820

Figure 23

Z.E. IVa

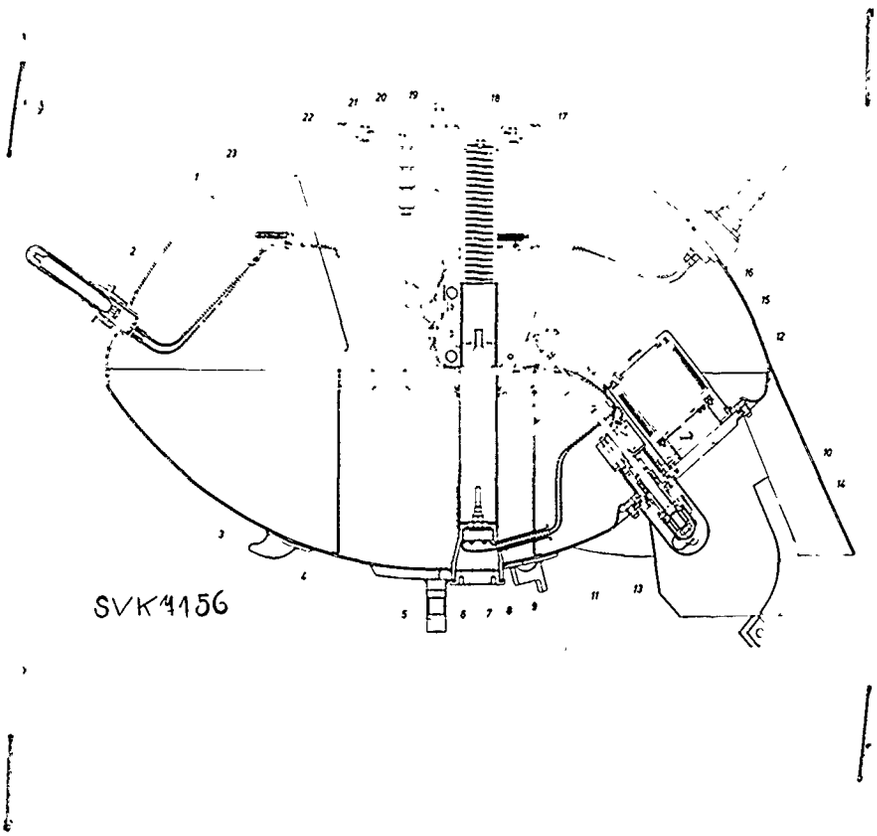


Figure 24

The Z.E. IVa as Used in the CMA/X

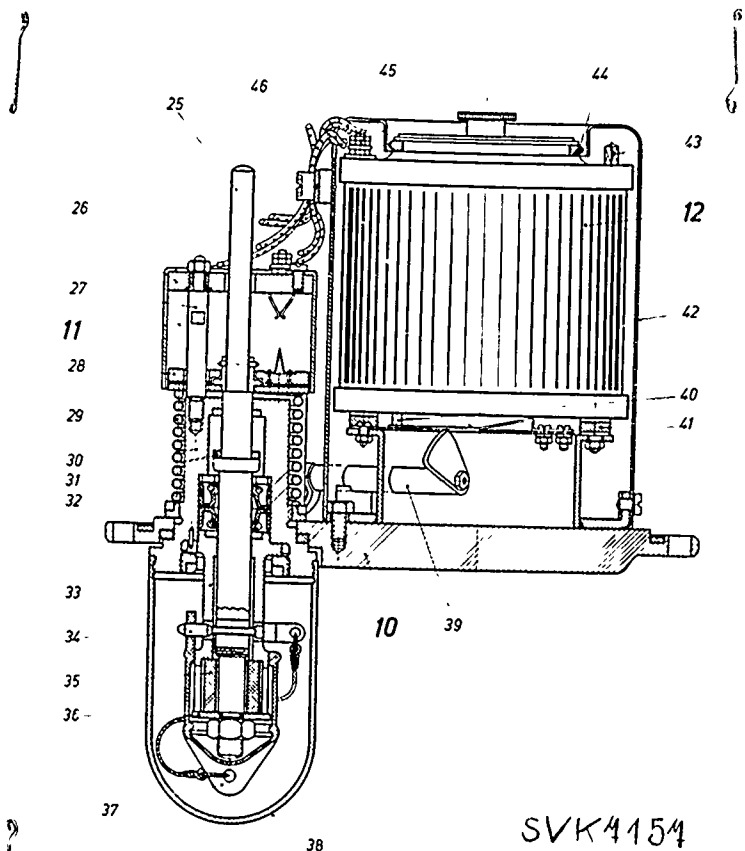
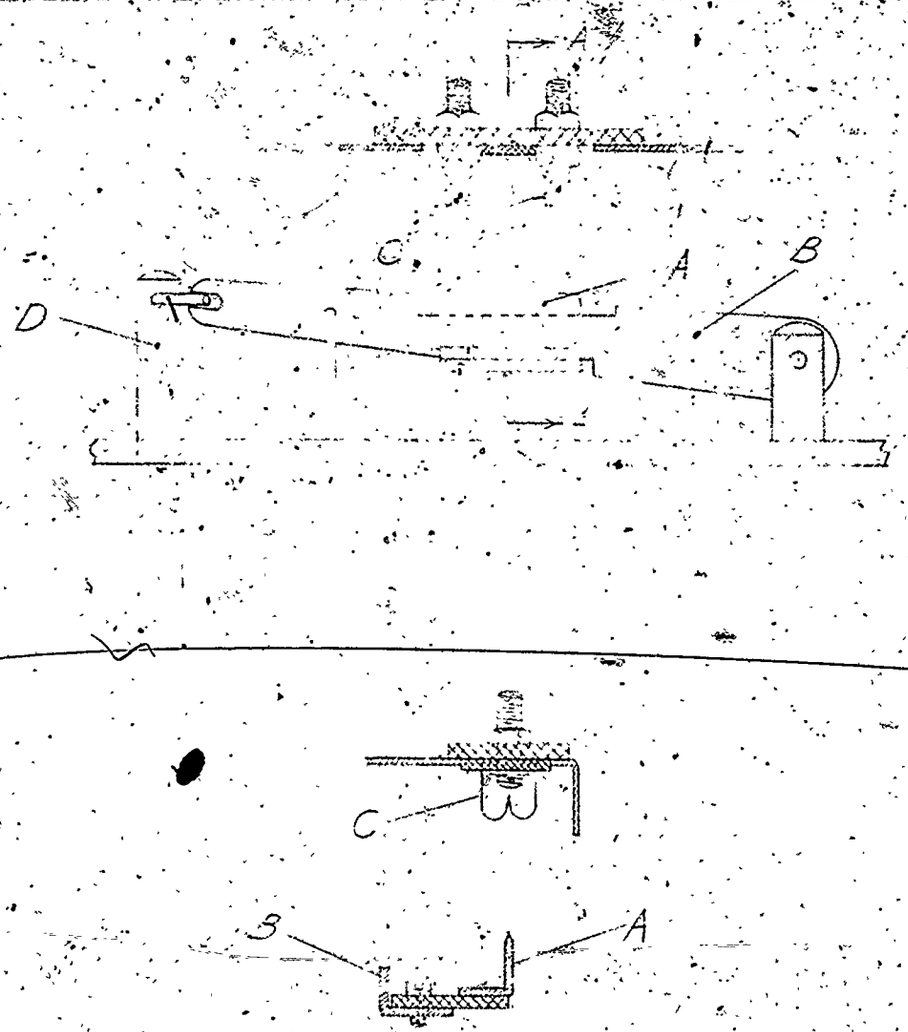


Figure 25

The Z.E. IVa Mounted on the OMA/K Base Plate



SECTION A.B. A-A

FIG. 26

ZE-IV-A

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M. Hor. Reel-AWe B DIN A4 Master 43

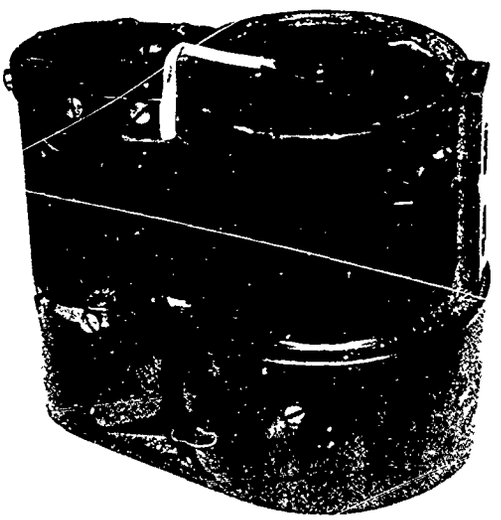
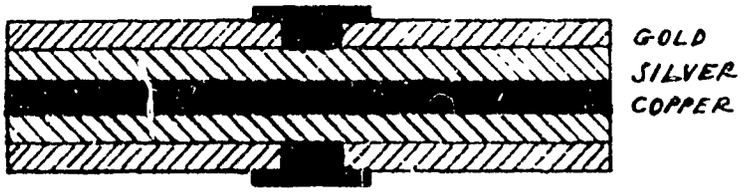


Figure 27

Z.E. VI



CROSS-SECTION OF ZE-VI ELECTRODE

FIG. 28

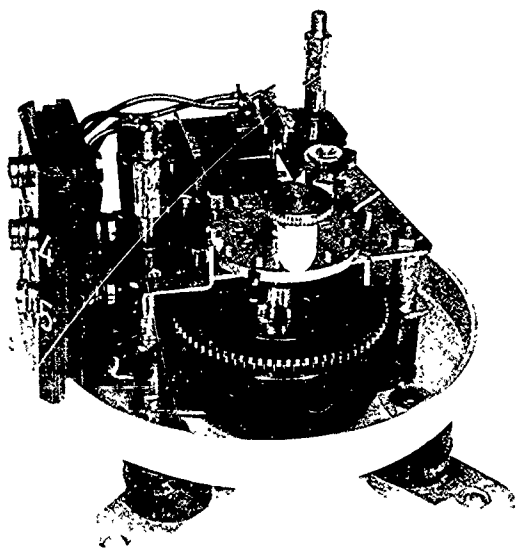


Figure 29

Z.K. II

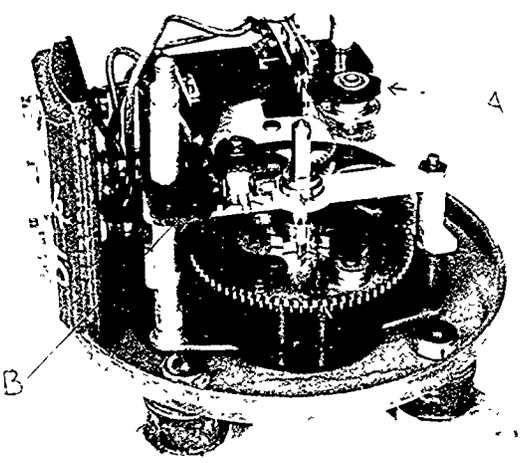


Figure 30

Z.K. IIe

Key to Figures 32, 33, 34, and 35

1) Securing Lugs
2) Case
3) Terminal Board
4) Spring Container
5) Driving Gears
6) Escapement
7) Star Switch
8) Disc Cam
9) Leaf Spring
10) Grooved Switch Roller
11) Leaf Springs
12) Day Indicator Dial
13) Solder Plug Holder
14) Solder Plug Fuse-delay Switch
15) Starting Lever
16) Spring Contact
17) Setting Dial
18) Switch Screw
19) Setting Dial Bearing
20) Setting Mark
21) Winding Spindle
22) Day Indicator Dial
23) Holding Screw

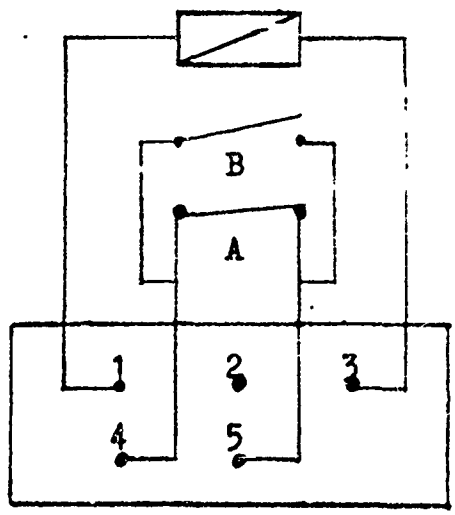


Figure 31

Wiring Diagram for Z.K.IIe

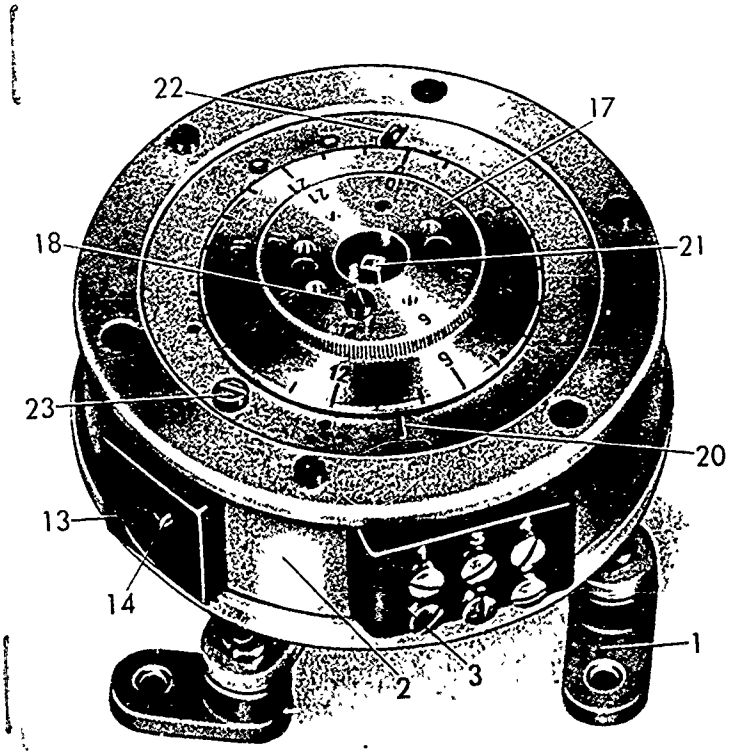


Figure 32

Pausenuhr (P.U.)

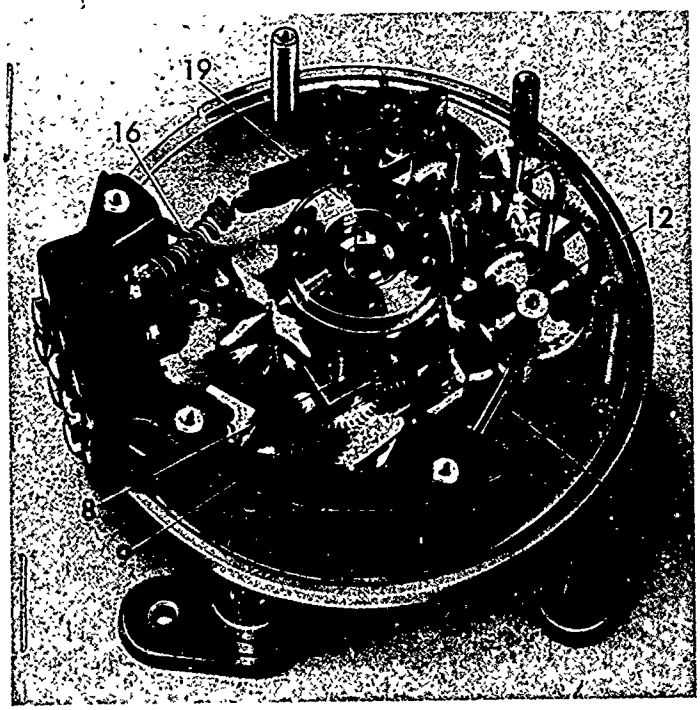


Figure 33

Pauzenuhr Clock Work

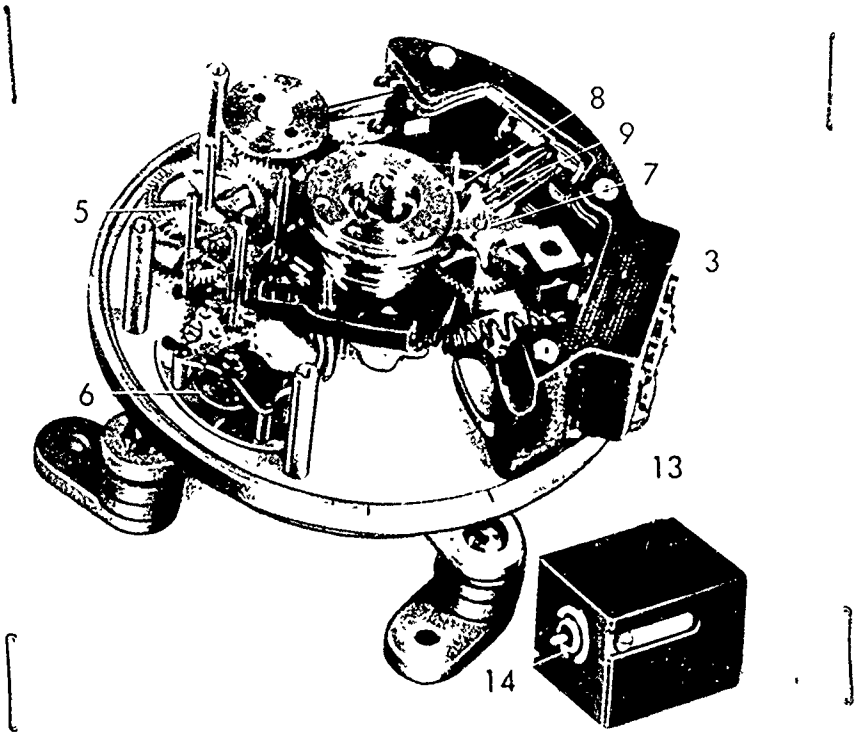


Figure 34

Pausenuhr Showing Fuse Delay Switch

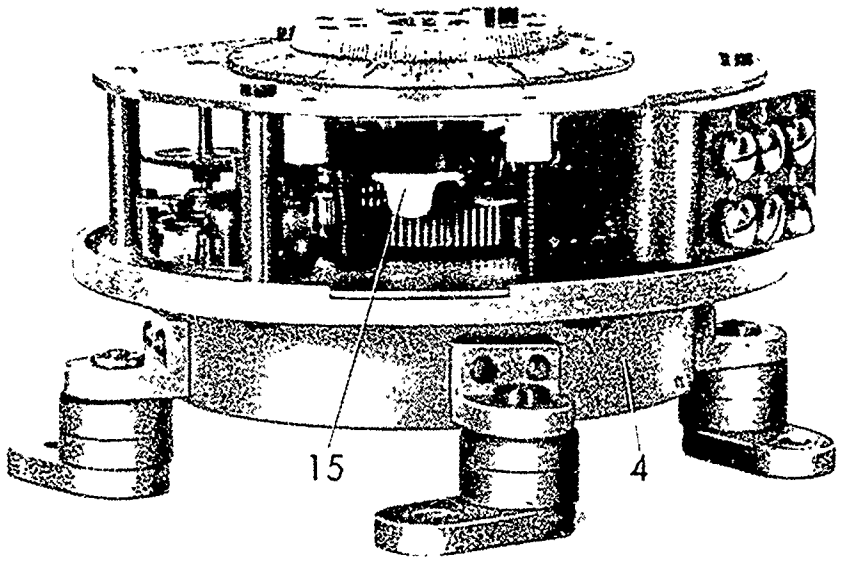


Figure 35

Pausenuhr Showing Starting Lever

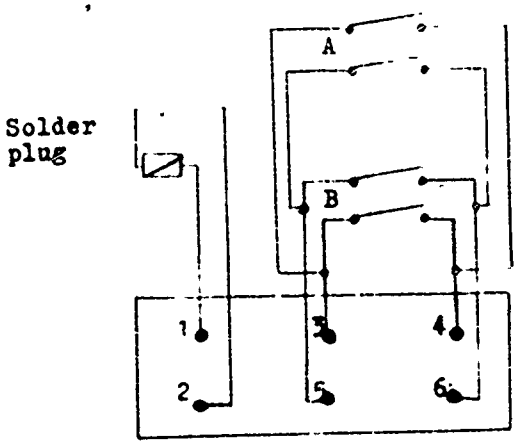


Figure 36
Wiring Diagram for Pausenuhr

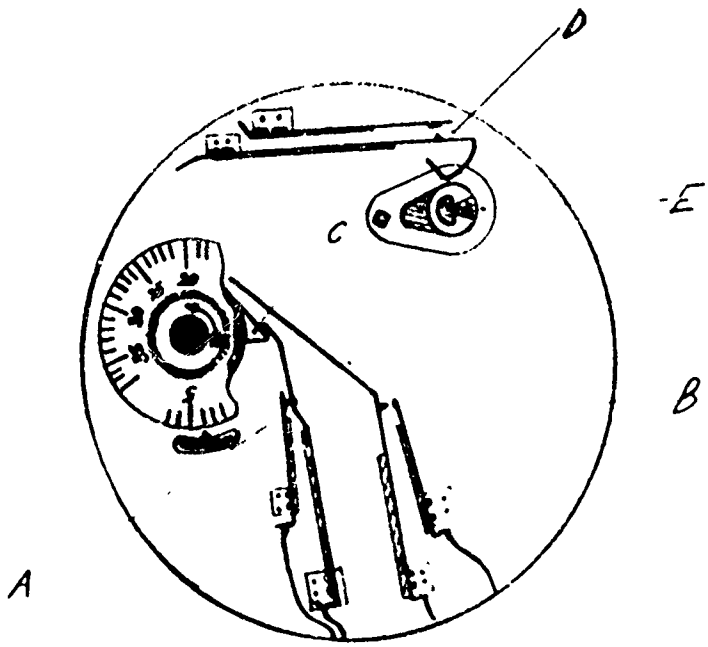


Figure 37

VK II

[redacted] UNCLASSIFIED

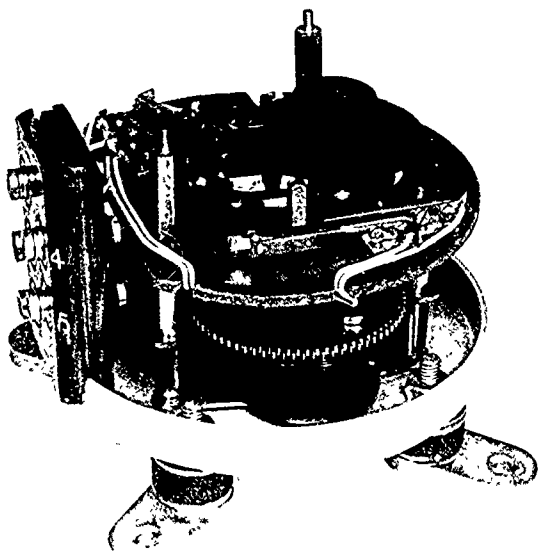


Figure 37a

V.K. II

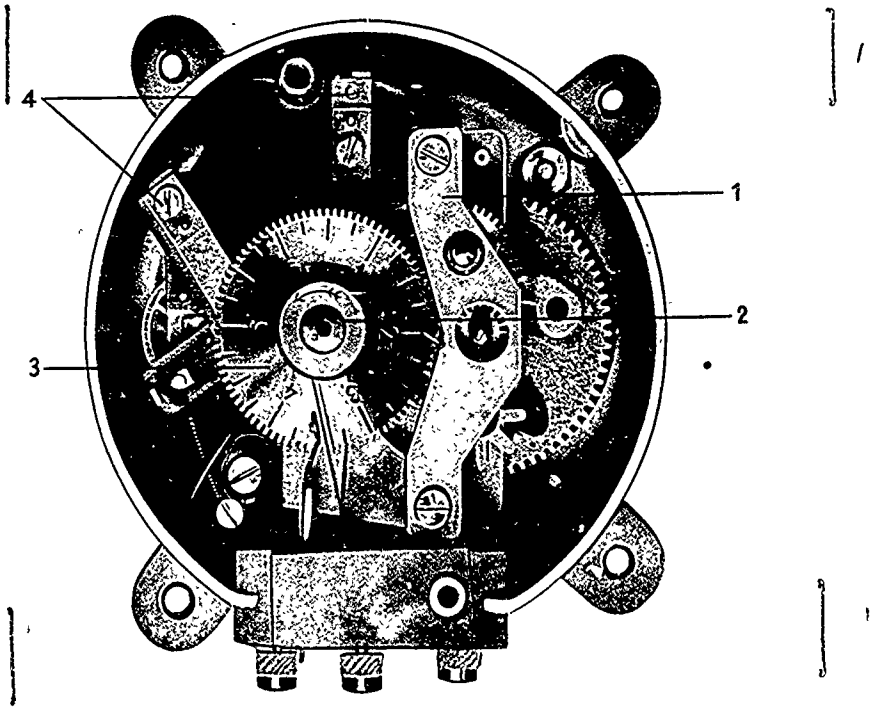


Figure 38

Verzogerung Werke (VW)

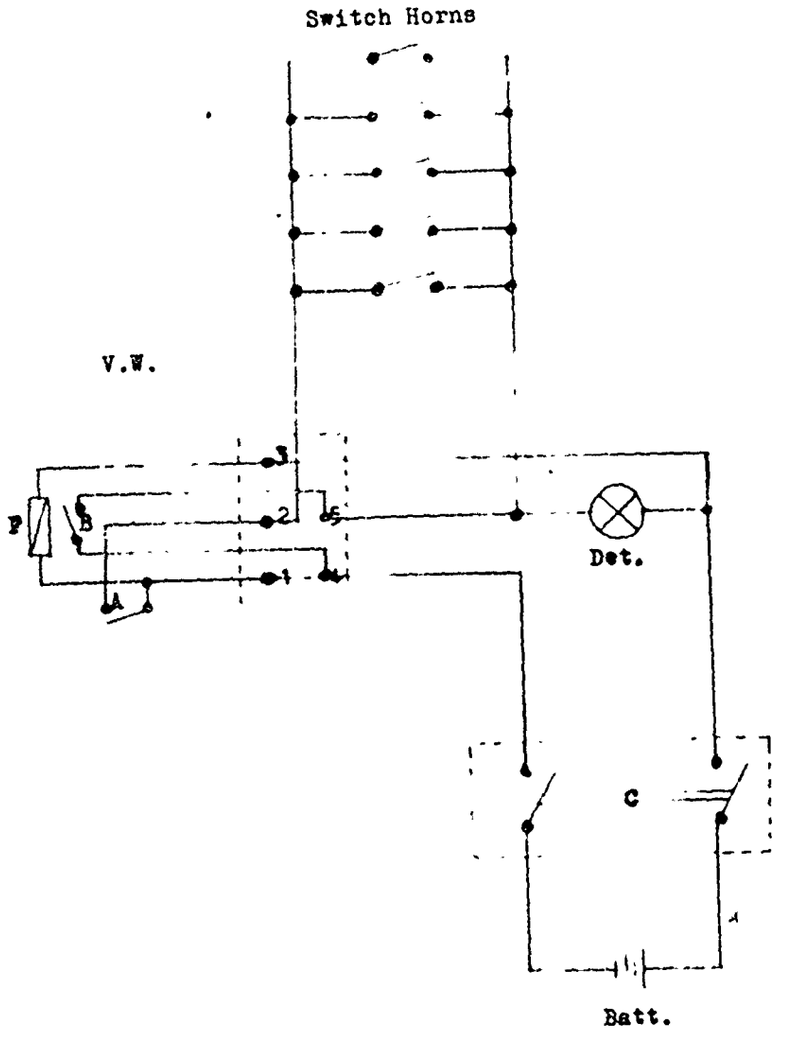


Figure 39

Wiring Diagram Showing the V.W. in the EMS Mine Circuit